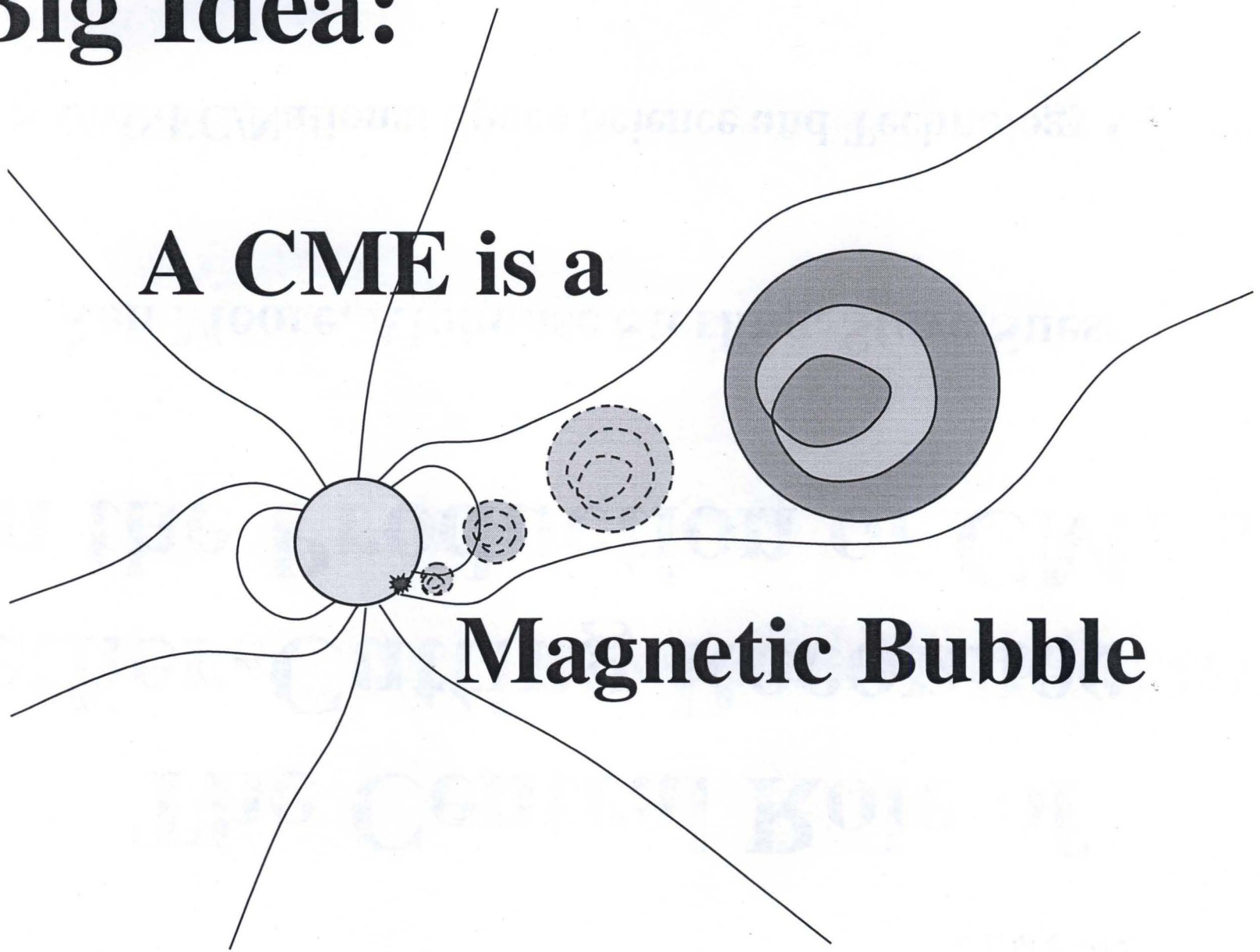
The Central Role of Tether-Cutting Reconnection in the Production of CMEs

Ron Moore, Alphonse Sterling, Steve Suess

NASA/MSFC/National Space Science and Technology Center

Big Idea:



A CME is a

Magnetic Bubble

Main Points

- **The standard scenario for CME production is basically the right picture.**
- **A CME is a magnetically inflated (low-beta) "plasmoid with legs."**
- **Tether-cutting reconnection does <u>most</u> of the building and unleashing of the CME plasmoid.**
- **Tether-cutting reconnection is <u>only one way</u> to trigger a CME explosion.**
- **The CME propels itself by pushing on the surrounding coronal magnetic field.**

Outline

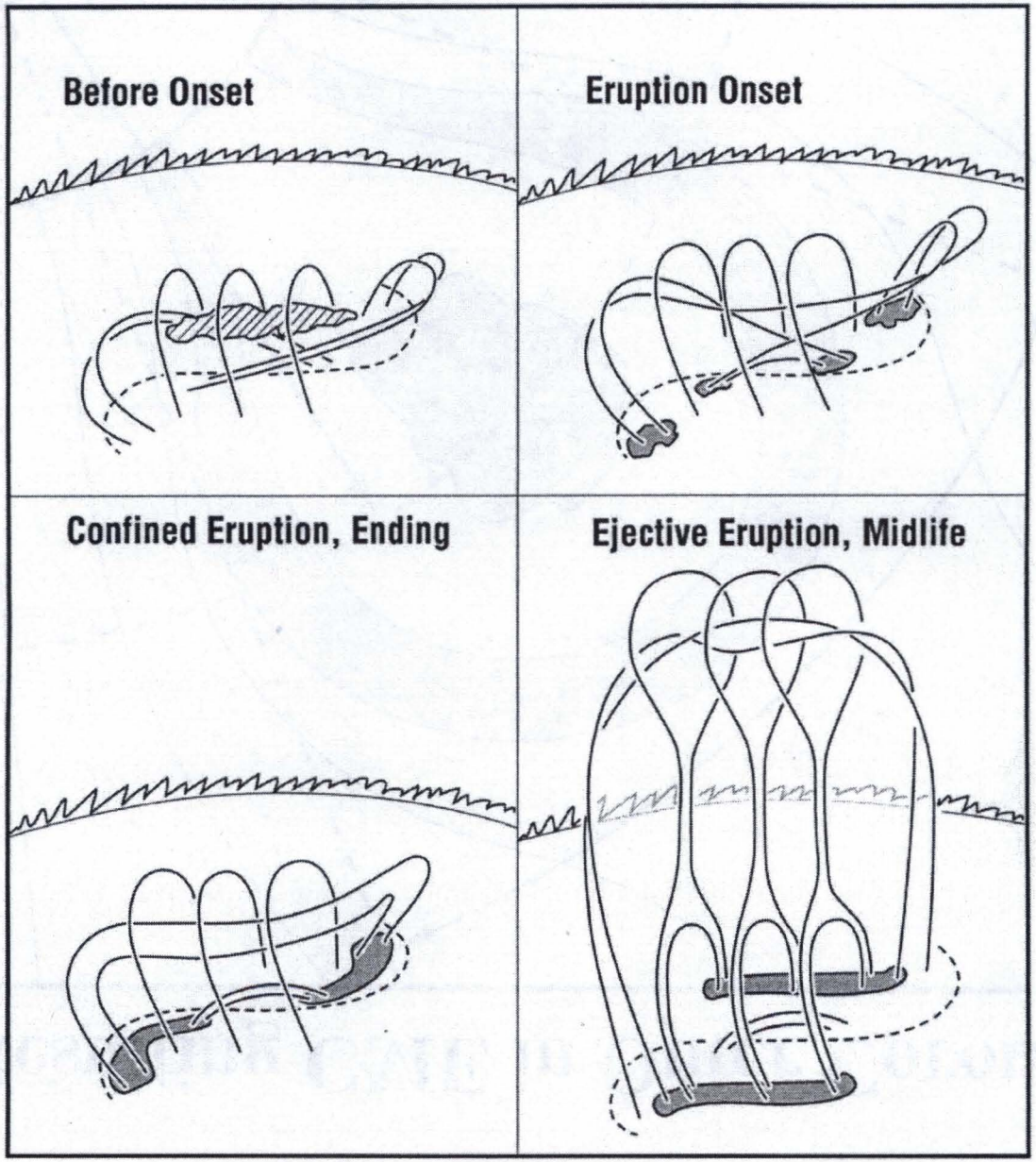
I. Introduction

II. Standard Scenario for CME Production

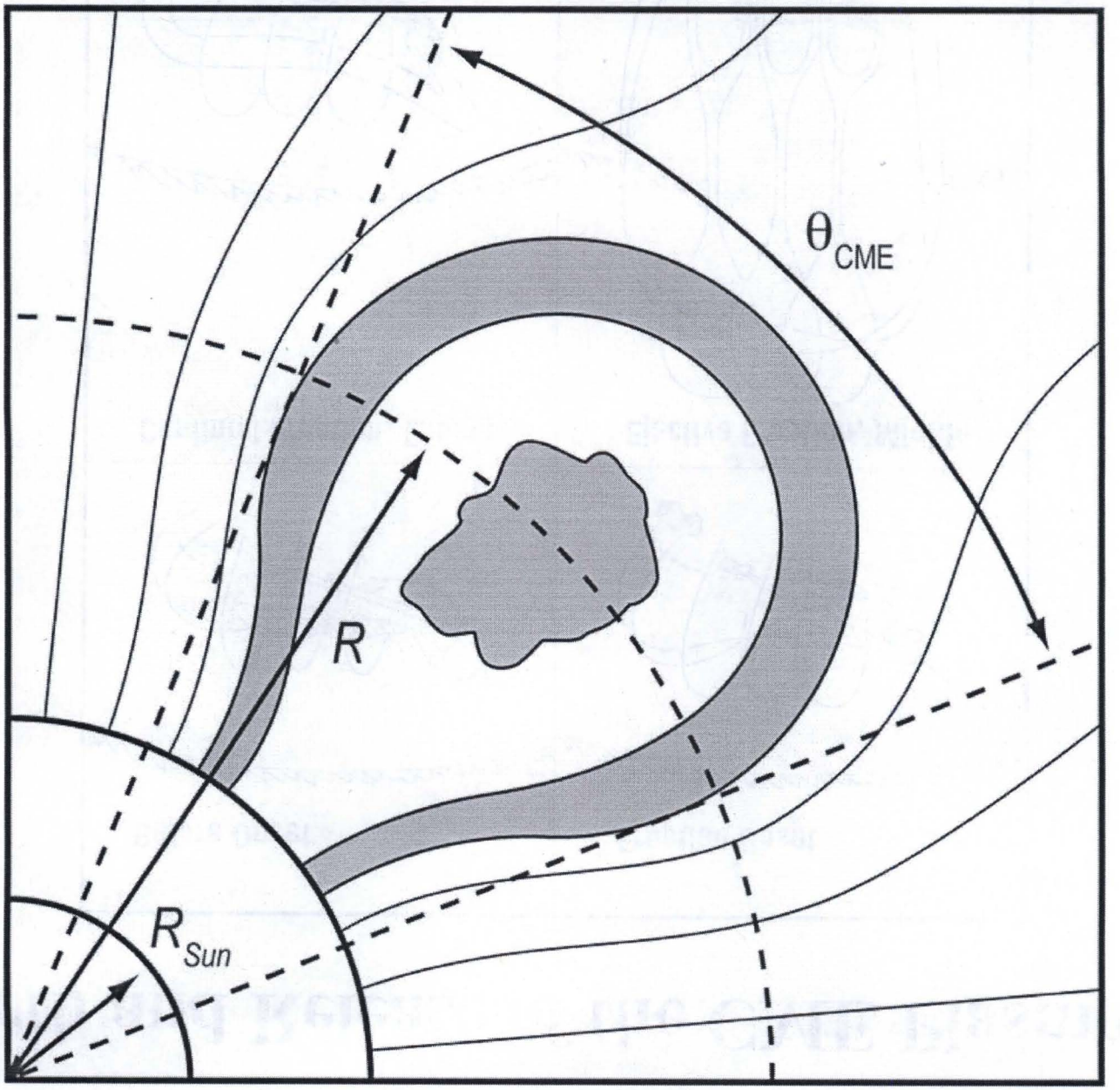
III. New Observational Test

IV. Conclusion

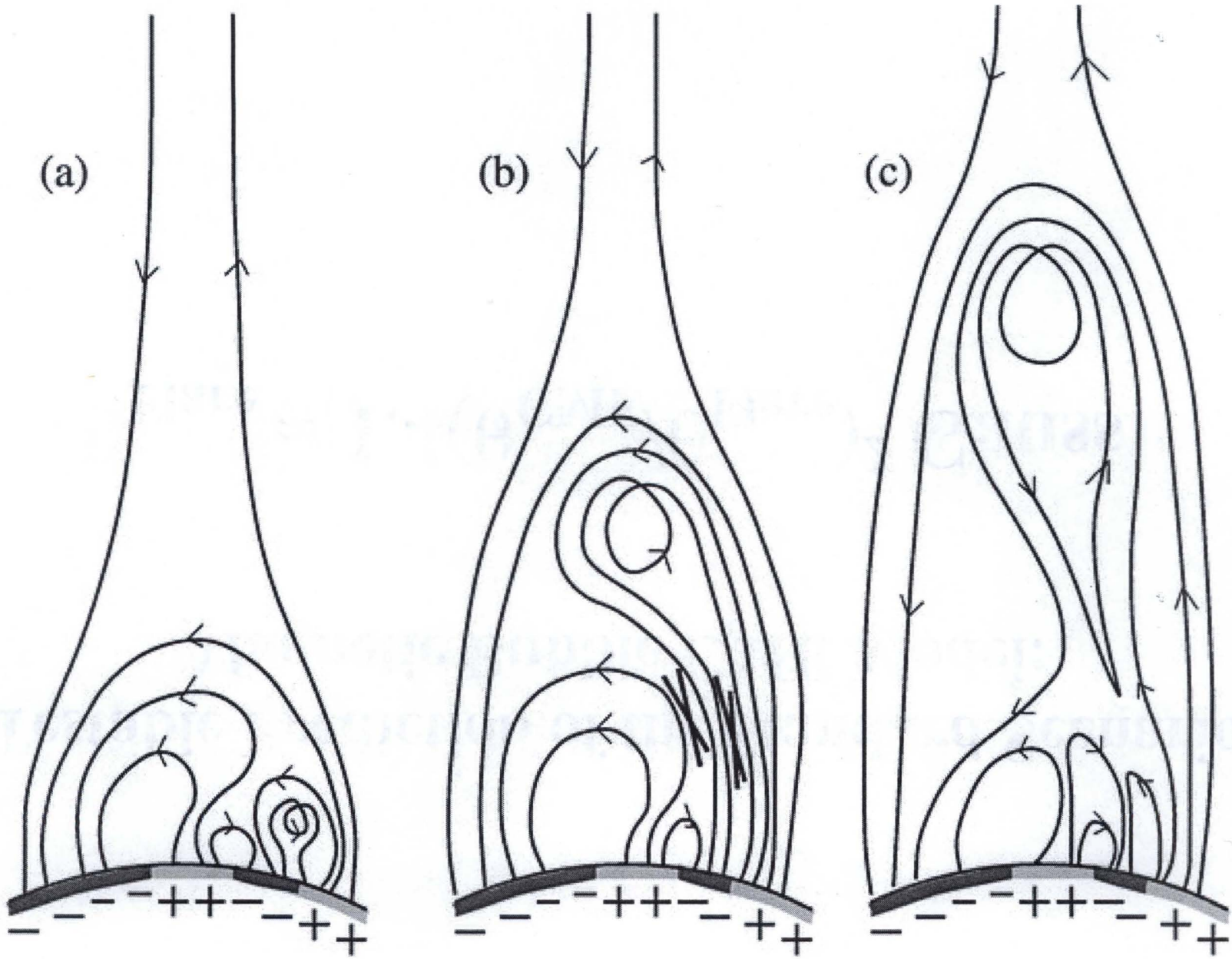
Birth and Release of the CME Plasmoid



Resulting CME in Outer Corona



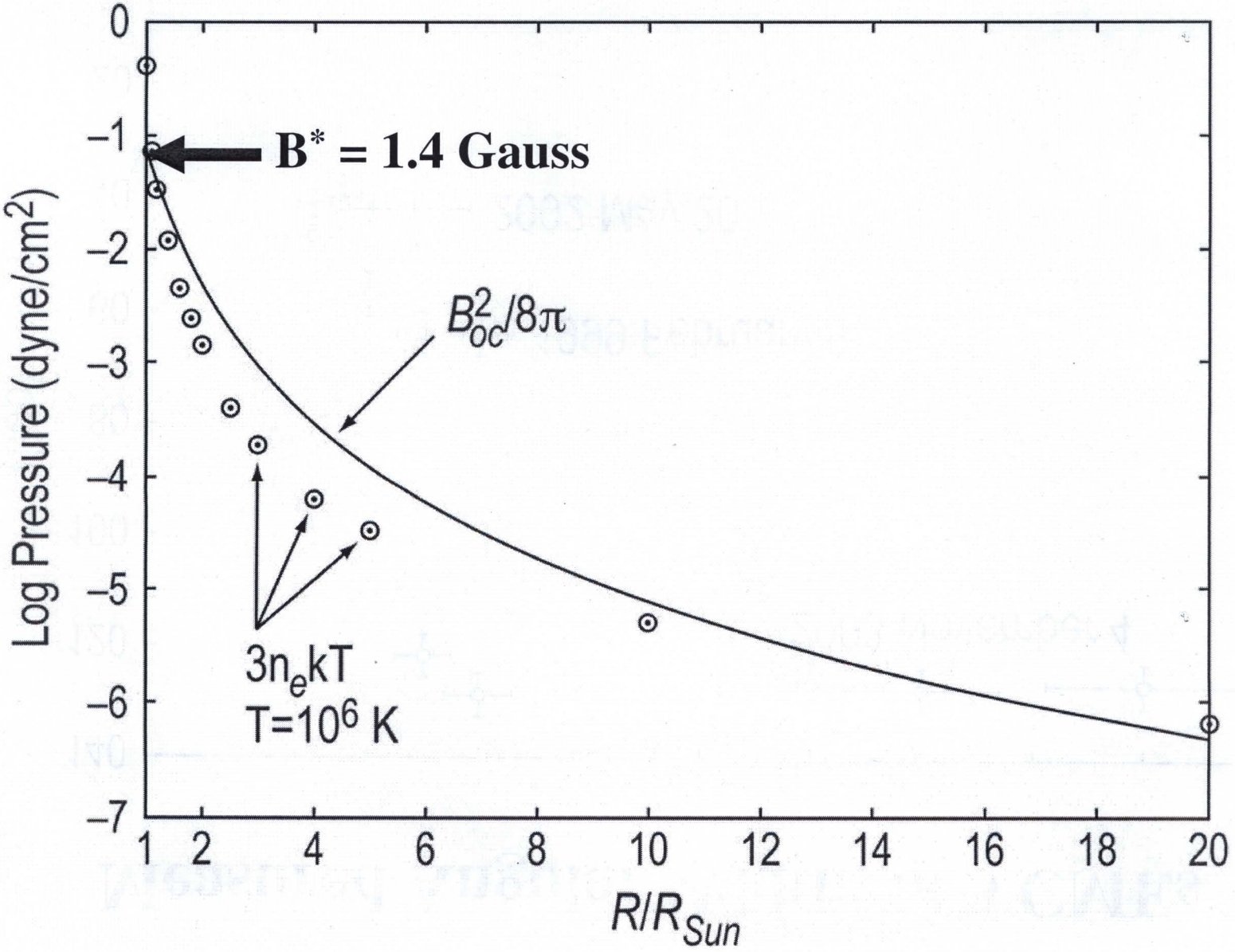
Governing Role of Surrounding Field



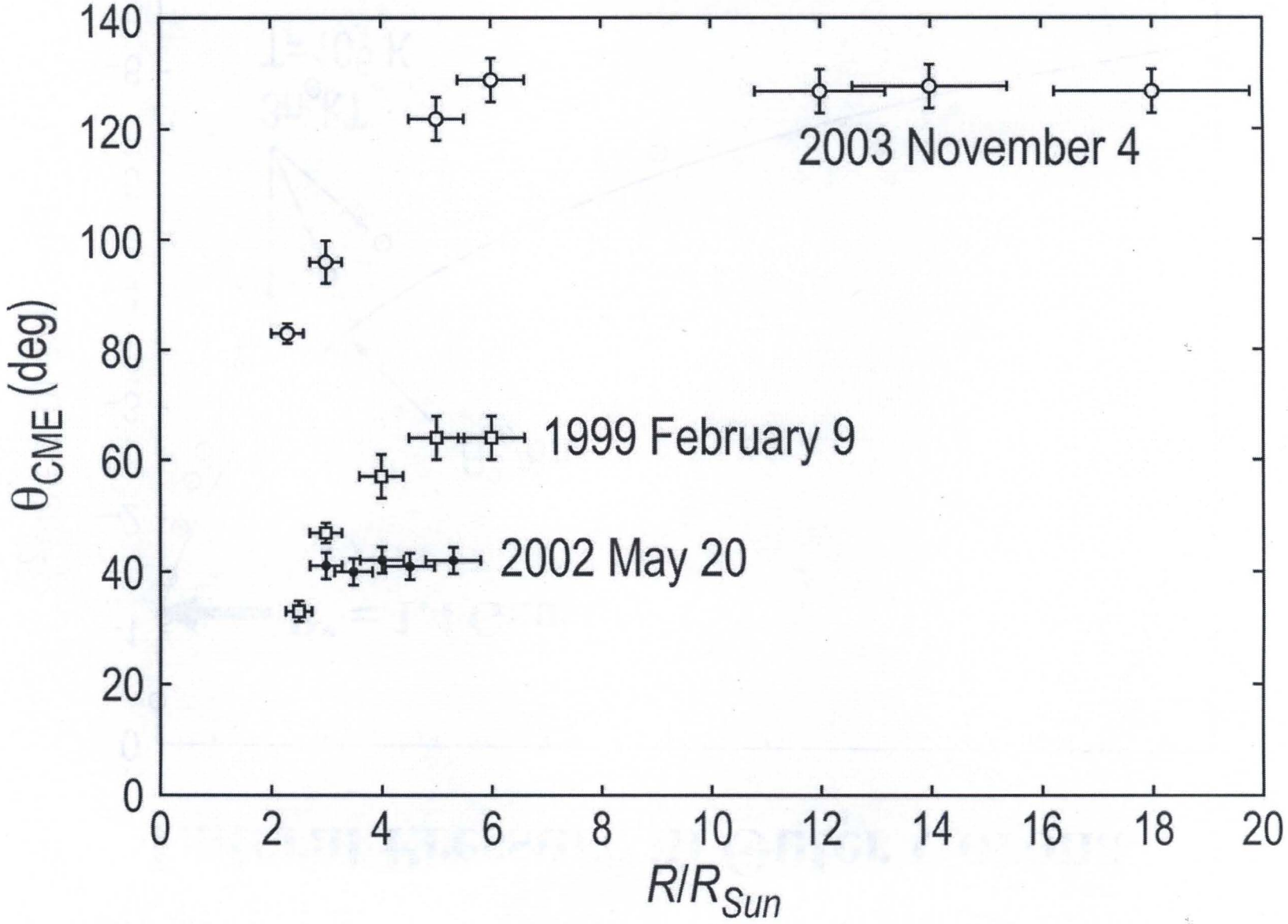
Testable Prediction of the Standard Scenario Magnetic Bubble CME Model:

$$B_{Flare} \approx 1.4(\theta_{CME}/\theta_{Flare})^2 \text{ Gauss}$$

Lateral Pressure in Outer Corona

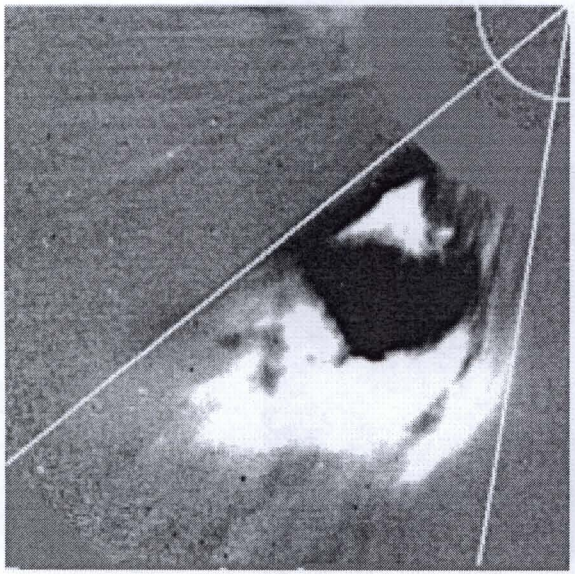


Measured Angular Widths of 3 CMEs



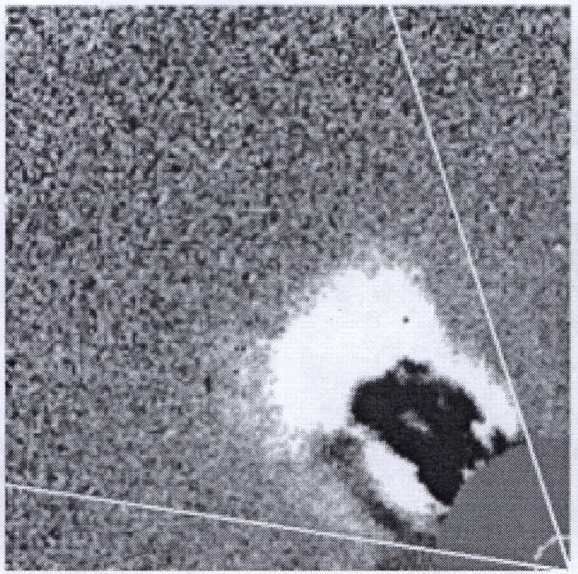
LASCO Image of each CME at Final Width

2002 May 20



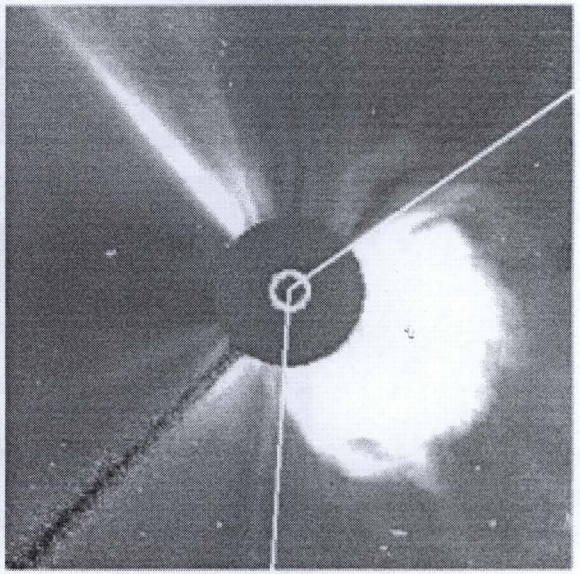
C2 Difference Image

1999 Feb 9



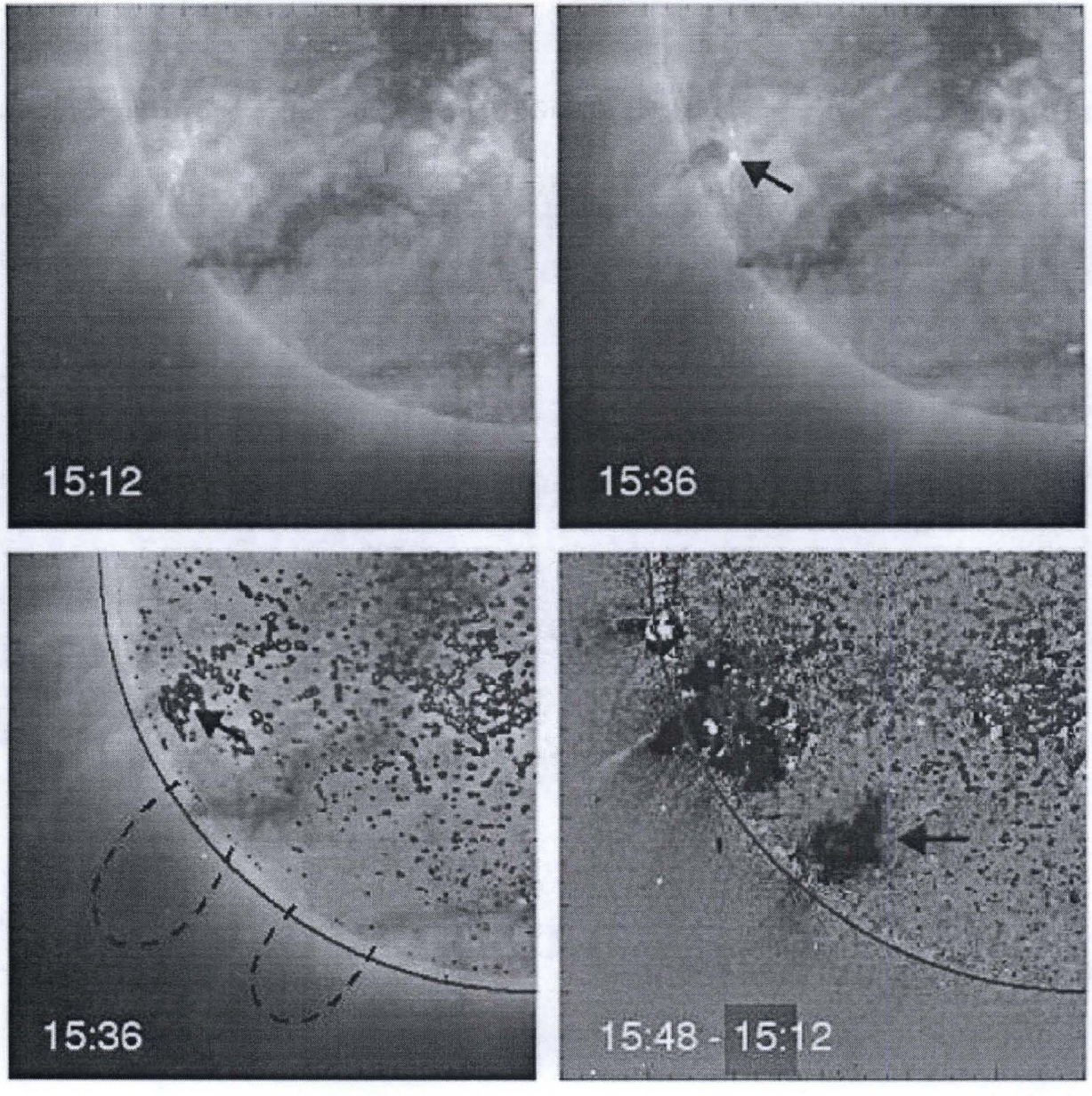
C3 Difference Image

2003 Nov 4

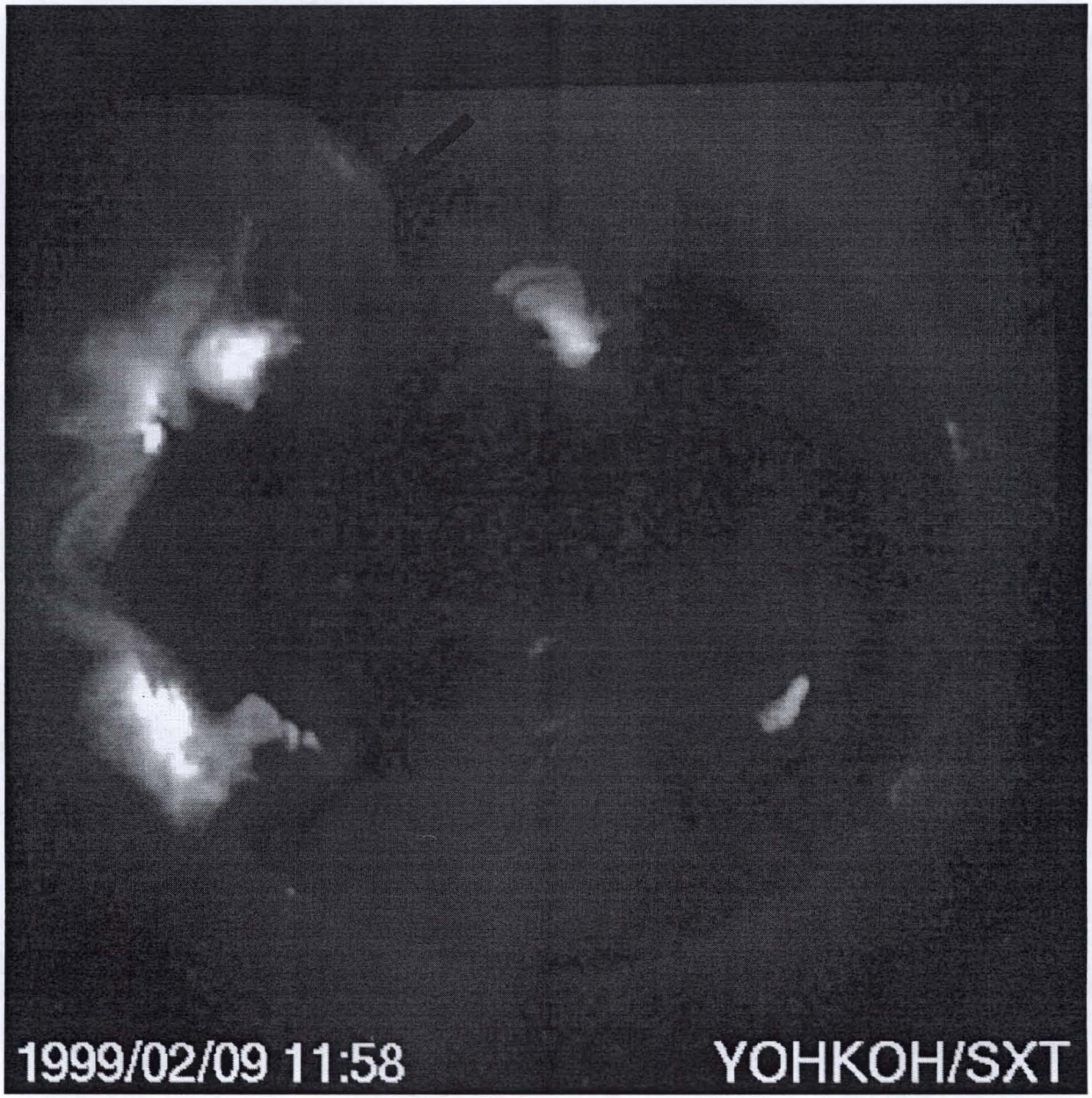


C3 Normal Image

Source of the CME of 2002 May 20

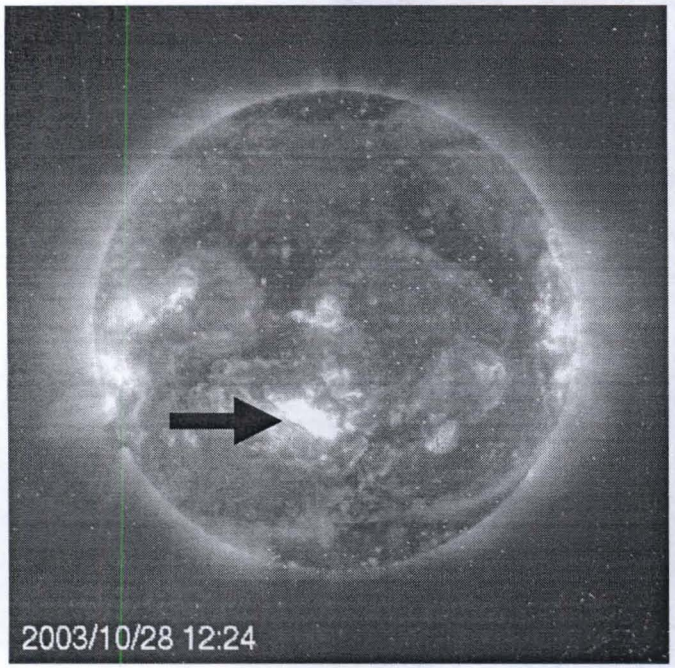


Source of the CME of 1999 Feb 9



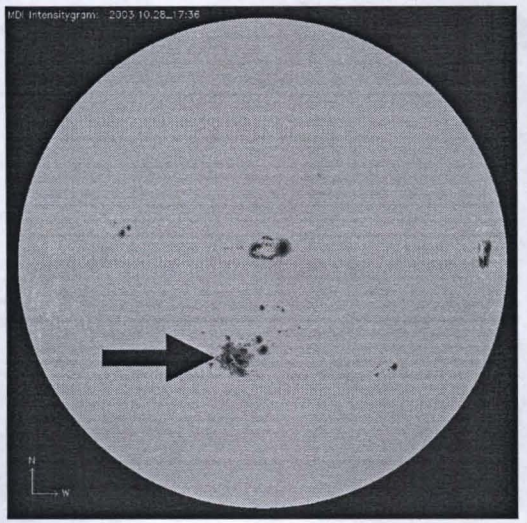
Source of the CME of 2003 Nov 4

Oct 28 X17 Flare Arcade



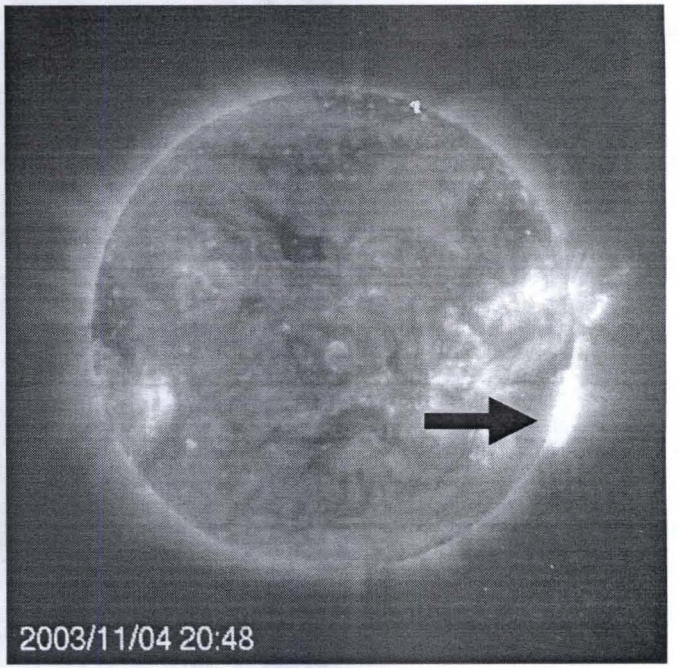
EIT 195 Å Corona

Giant δ Sunspot Centered Under Flare Arcade



MDI Photosphere

Nov 4 X20 Flare Arcade



EIT 195 Å Corona

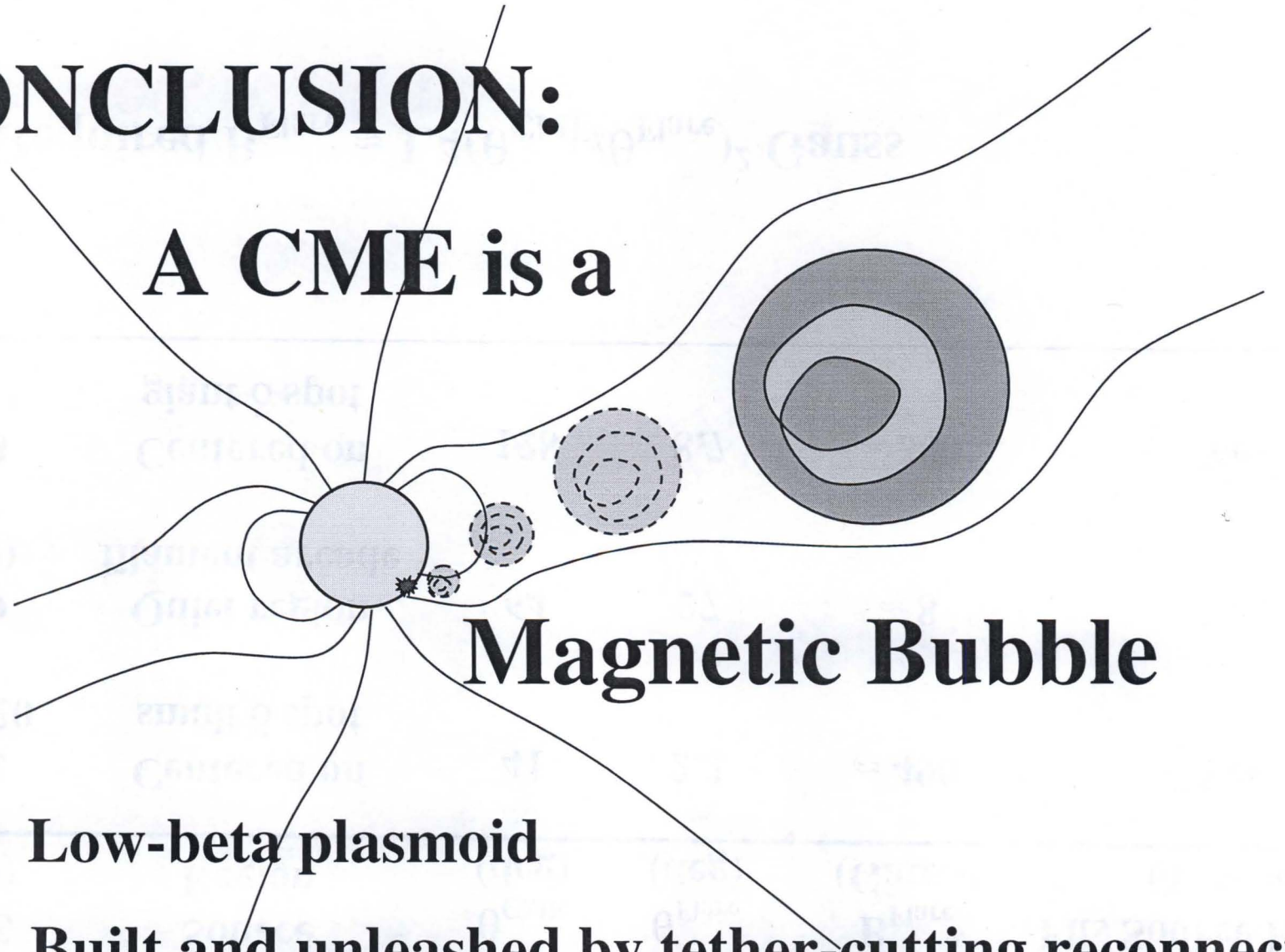
Test Results

CME (date)	Source Region	θ_{CME} (deg)	θ_{Flare} (deg)	Required* B_{Flare} (Gauss)	Required B_{Flare} Fits Source Region? (Yes/No)
2002 May 20	Centered on small δ spot	41	2.2	≈ 490	Yes
1999 Feb 9	Quiet region filament arcade	64	27	≈ 8	Yes
2003 Nov 4	Centered on giant δ spot	128	8.7	≈ 300	Yes

* Required $B_{Flare} \approx 1.4(\theta_{CME}/\theta_{Flare})^2$ Gauss

CONCLUSION:

A CME is a



Magnetic Bubble

- **Low-beta plasmoid**
- **Built and unleashed by tether-cutting reconnection**
- **Propelled by own magnetic field pushing on surroundings**